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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 5 :
F16S 3/00, 3/06, B21B 1/38
B21B 1/22, B21D 13/04

A1

(11) International Publication Number: WO 93/15353

(43) International Publication Date: 5 August 1993 (05.08.93)

(21) International Application Number: PCT/AU93/00035

(22) International Filing Date: 25 January 1993 (25.01.93)

(30) Priority data:
PL 0546 24 January 1992 (24.01.92) AU

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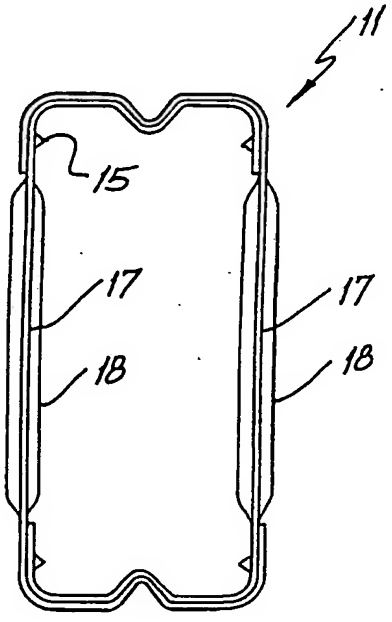
(81) Designated States: AT, AU, BB, BG, BR, CA, CH, CZ, DE, DK, ES, FI, GB, HU, JP, KP, KR, LK, LU, MG, MN, MW, NL, NO, NZ, PL, PT, RO, RU, SD, SE, SK, UA, US, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, SN, TD, TG).

Published
With international search report.

(54) Title: ELEMENT FOR COMPOSITE STRUCTURAL MEMBER

(57) Abstract

A channel shaped structural element (12) for use with a complementary channel shaped structural element of like profile to form a composite structural member (11), each element (12) comprising: a web (17), upper and lower main flanges (13) separated by the web (17), a return (14) on each of the upper and lower main flanges (13) which forms a subflange (14), characterized in that the web (17) is provided with transversely or vertically extending corrugations (18) which provide increased resistance against buckling.



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ELEMENT FOR COMPOSITE STRUCTURAL MEMBER

This invention relates to a structural element which can be formed from strip metal by a roll forming process, and which possesses high strength, being highly resistant to deflection under load and highly resistant to buckling and which may be used to form a composite structural member.

This invention also relates to a bracket which can be used to form a joint between such composite structural members, and in particular relates to a bracket which has specific advantages in relation to load transfer.

Reference can be made to an associated application, Australian Patent Application No. 69549/91, wherein a structural member is described which has better strength characteristics than previously known structural members, and was formed by springing together two generally "C" section members, each of which had a web with a pair of ribs extending along it, upper and lower main flanges terminating along their edges in sub-flanges directed towards each other, and each sub-flange terminates in a lip directed back towards the web. The lips of each component engaged respectively outer and inner surfaces of the ribs of the other component and that inhibited displacement of contiguous flanges and maintained a high moment of inertia which in turn inhibited excessive deflection of the member under load.

Structural members made in accordance with that invention have been outstanding and have been successful commercially, and appear to be superior to any alternatives known to the applicant.

One object of this invention is to provide still further improvements whereby the resistance to deflection and to buckling under load of a structural member are both substantially increased. This is enabled by use of corrugations in the web portion of a structural element used with a like element to form a structural member. When a structural member according to the aforesaid patent application is tested to destruction, the destruction would usually occur by buckling of both the webs and flanges, with premature separation of the flanges facilitating premature

failure. Premature failure is further facilitated by relative sliding of the flanges with respect to one another. This sliding does not reduce the section stiffness, but does affect its load carrying capacity.

Another object of this invention is to provide improvements whereby a composite structural member formed by complementary structural elements can function like a box section, and inhibit premature failure.

Extensive development and experimentation has taken place, and this invention has established a marked improvement over the aforesaid invention, in that this invention provides structural elements which combine to form a structural member of a specific configuration which resists horizontal shear, and also provides the webs with a configuration which resists buckling. Also the corrugations impart stiffness and strength to the web enabling use of thinner guage material for the profiled element.

In one embodiment of the invention, a composite structural member comprises two similar section structural elements, each of which has a web, upper and lower main flanges, and sub-flanges, but in this embodiment the sub-flanges and webs are interengaged by short stakes or other fastening means to inhibit sliding due to horizontal shear forces, and the web is provided with transversely (or vertically) extending corrugations which resist the buckling forces, allowing use of a deeper section thin plate. If the corrugations in the webs terminate adjacent to the sub-flanges, they are sufficiently close to the bends between the webs and main flanges that failure at that locality is unlikely to occur, and since there is a double metal thickness in any case at that locality, the strength imparted by the composite structural member is very much superior and in the order of 25% to 30% better than has been achieved with the aforesaid prior art structural member.

The invention, however, is not merely limited to the structure of the member, but also extends to a method of forming and fabricating a high strength structural member, wherein the webs, flanges and sub-flanges are preformed by roll forming processes. The two structural elements are

sprung together, and are subsequently staked by a plurality of stakes or other fasteners which can, for example, be inturned tabs pierced between dies at a staking station, or alternatively they may be pierced by piercing rollers during a further rolling process.

Still further, the invention extends to a structure wherein two complementary high strength structural elements overlap in a side by side configuration and are retained in that configuration against displacement to provide a long beam, placing the convex portions of one web contiguous with the concave portions of the web of an adjacent structural element, and locking those webs together with locking means.

In the broadest form of that aspect of the invention relating to the structural element the present invention comprises;

a profiled structural element for use with a complementary structural element of like profile to form a composite structural member; each profiled element comprising; a web, upper and lower main flanges separated by the web, a return on each of the upper and lower main flanges which forms a sub-flange, characterised in that the web is provided with transversely or vertically extending corrugations which provide increased resistance against buckling.

In the broadest form of the method aspect the present invention comprises;

a method of construction of a profiled structural element as herein described comprising the steps of:

(a) folding a metal sheet of predetermined length and width to form a substantially channel shaped element,

(b) either before or after the folding, forming corrugations in that part of the sheet which forms the web of the element, by either stamping or rolling.

In another form of the method aspect, the invention comprises;

a method of construction of a profiled structural element as herein described, for use with a like profiled element to form a composite structural member, comprising the steps of:

(a) taking a metal sheet of a predetermined width and length,

(b) bending the sheet by use of a series of rollers so as to form a substantially channel shaped member, comprising a web, upper and lower main flanges and a return on each of said upper and lower main flanges forming sub-flanges,

(c) roll forming the channel member during or after its formation to form ribs in the sub-flanges,

(d) forming corrugations before or after step (b) transversely or vertically in the web of the profiled element.

In a further aspect of the invention, a bracket is provided which may be suitable for forming joints between composite structural members. Although this bracket will be specifically useful in relation to the composite structural member described herein, it should be realised that other structural members, tubular or otherwise, will also be suited to use with this aspect of the invention.

One major difficulty with the use of any structural member, and in particular with hollow structural members, is the forming of joints between adjacent members. A typical example of this is in the formation of a roof truss.

In the example of a roof truss, the various truss members join one another at a variety of angles. Conventionally, some form of connector plate with fastening members is used to bridge a joint between the two structural members so as to form a joint.

However, in relation to the structural member described in this application, the web of the beam section is relatively thin, and therefore unable to support any substantial load. Therefore, the use of overlapping plates is inappropriate, and other connection devices will result in a joint that is both costly and time consuming to produce.

Therefore, it is a further object of this invention to provide a bracket which may be used for forming a joint between structural members which overcomes the abovementioned problems.

In its broadest form, this further aspect of the

invention comprises a bracket having at least one side wall and a connector plate attached to the side wall, and at least one aperture formed between the side wall and the connector plate.

Preferably, the bracket is a U-shaped channel having a pair of side walls and a connector plate between the side walls. In respect of the U-shaped channel, a pair of apertures may be formed at each intersecting edge between the connector plate and the side walls.

In use, the bracket may be located over and then secured to a structural member such that there is a clearance between the side wall and the structural member. A fishplate may be inserted through the aperture and secured between both the bracket and the structural member. The joint may be finished by securing a structural member to the other end of the fishplate.

Further, the clearance between the side wall and structural member may be sufficient to allow insertion of at least two fishplates so that more than one structural member may be joined at one particular point to another structural member.

Preferably, the fishplate comprises a flat plate having a U-shaped bracket at one end which allows connection of the structural member within the U-shaped portion of the fishplate.

The invention will now be described in more detail according to preferred but non limiting embodiments of each aspect of the invention and with reference to the accompanying illustrations wherein,

Fig. 1 is a fragmentary side elevation of a composite structural member constructed according to this invention,

Fig. 2 is an end view of Fig. 1,

Fig. 3 is a fragmentary section taken on line 3-3 of Fig. 1,

Fig. 4 is a view similar to Fig. 2 but drawn to a larger scale,

Fig. 5 shows a piercing station for the piercing of stakes to join the webs to the sub-flanges,

Fig. 6 is a side view of Fig. 5,

Fig. 7 is a top view of a die contained within the section,

Fig. 8 shows the configuration of two overlapping structural members side by side retained together by a flange edge stiffener,

Fig. 9 is a fragmentary view of a portion of Fig. 8 showing the interengagement of the corrugations of the contiguous webs near the ends of the two structural members, and

Fig. 10 is a plan view and an end view which illustrates the configuration utilising the locking arrangement of Figs. 8 and 9,

Fig. 11 shows a side elevational view of a joint formed between three structural members,

Fig. 12 shows a cross-sectional view of Fig. 11, and

Fig. 13 shows orthrographic views of a bracket used at the joint shown in Fig. 11 and Fig. 12.

Referring first to Figs. 1 through to 4, there is shown a high strength structural member 11 which comprises two identical structural elements 12 which are roll formed and subsequently sprung together to form the configuration shown in Figs. 2 and 4.

Each element 12 comprises an outer flange 13 with a return sub-flange 14 staked thereto by a plurality of stakes 15 which in this embodiment are of generally triangular shape and are formed by piercing the webs and the sub-flanges to form flange edge stiffening means, although use can be made of alternative arrangements such as spot welding, intermittent welding, blind rivets or other fasteners.

The sub-flanges 14 extend for only a short portion of the depth of the webs 17, one sub-flange terminating externally on one web and the other internally on the other web as illustrated, and these are staked as described below with respect to Figs. 5, 6 and 7.

Each web 17 comprises a plurality of transversely or vertically extending corrugations 18 which may be triangular, rectangular, trapezoidal or of other shapes, but the preferred shape is the sinusoidal shape shown in Fig. 3

since it avoids sharp corners which can cause stress concentrations. The sinusoidal shape is best formed in the web by stamping. To avoid stress concentrations in the material in or around the corrugations, the corrugations may each be tapered so that the corrugations are deeper at the centre of the web. The corrugations will be seen to be formed intermediate the edges of the sheets from which the elements 12 are roll formed, so that there is ample metal beyond the ends of the corrugations for limiting distortion of the metal sheet, and in any case, such distortion is further limited by the roll forming of the flanges and sub-flanges. Further to that, it is important to note that the corrugations can be made to terminate adjacent the sub-flanges so that a load will have the effect of being transferred from the double thickness of flanges of elements 12 and sub-flanges 14 directly to the top and bottom ends of the corrugations 18 in the configuration shown in Fig. 4. The corrugations may be configured according to parameters dictated by the thickness of the material. Ideally the corrugations have a wavelength within the range of 6 times to 80 times the thickness of the structural element material. The pitch is ideally within the range of 2 times the thickness to 20 times of the material. The crest of each corrugation has a radius within the range of 5 times to 10 times the thickness of the element material. Preferably the thickness of the material would fall within the range of 0.3 mm to 1.0 mm. The combination of the stakes 15 which inhibit sliding movement due to shear forces, and the corrugations 18 which inhibit buckling of the webs, create a very stiff and strong structural member.

If the stakes are as shown, and there is no use of additional components such as fasteners, the formation requires some consideration and in this embodiment the stakes are formed as shown in Figs. 5, 6 and 7 at a staking station 20, wherein the assembled elements 12 are driven by rollers 21, six of which are shown above and six below a die back-up block 22 which is more specifically illustrated in Figs. 6 and 7, the die back-up 22 having upper and lower rollers 23 each of which is grooved at 24 to accommodate a

preformed rib 25 in the flanges 13. As shown, only one rib 25 extends along each flange 13 but in larger structures more than one rib should be used.

The rollers 21 and 23 have the function of maintaining the shape of section, and of progressing the assembled elements 12 over the die back-up block 22, the die back-up block 22 being retained in position by a tension rod 26.

The triangular stakes 15 are formed adjacent to the upper and lower edges of the back-up block 22. Although as illustrated the stakes can be formed with a reciprocating die, they can alternatively be formed with rollers. In the second case, instead of there being six rollers at the top flange and six rollers at the bottom flange as illustrated, two of the rollers in each instance would be rotatable about vertical axes and would be provided with lancing or piercing projections. Desirably the stakes 15 are arranged to be alternately directed in opposite directions to provide maximum strength no matter which way the beam is oriented in a structure.

Once the beams have been formed, the invention illustrated in Figs. 8, 9 and 10 can be used, wherein two structural members 11 are placed side by side over a supporting joist 28, with the outer surfaces contiguous, that is the convex portion 29 of the one member being placed in contiguity with the concave portion 30 of an adjacent member, and being locked together by a clamping plate 31 which retains the interlock between the lapped adjoining sections. The clamping plate 31 prevents the two sections from moving horizontally apart when a vertical load is applied, thus utilising the conical shapes of the corrugation tops and bottoms as means of vertical load transfer. If alternative corrugation shapes are used, the corrugation ends can nevertheless be functional to transfer the load. The intermediate surfaces of the corrugations substantially reduce the tendency for longitudinal movement of the members with respect to one another so that to some extent at least the adjoining members can function as a continuous beam comprising two structural members joined in the manner described. If fasteners are used to secure the

clamping plate 31, it will be seen that each fastener will pass through the clamping plate and the two metal thicknesses at the flange edges of the beams.

The results which have been achieved by utilising the above aspect of the invention are such that a stronger beam can be made of thinner material than any other roll formed beam otherwise known to the applicant.

This aspect of the invention is not necessarily limited to the sequence of operations described above, and for example the corrugations 18 can be formed before or after the roll forming operations wherein the flanges and sub-flanges are roll formed to shape.

Figs. 11 to 13 shows a bracket which is suitable for use in forming a joint between two or more structural members. In the examples shown in Figs. 11 to 13, the joint would be typically suitable for use in a roof truss.

As shown in Figs. 11 and 12, the bracket 32 is a substantially U-shaped member having side walls 33 and a connection plate 34.

As is best seen in Fig. 13, a pair of apertures 35 are formed along a portion of the bracket 32 along the intersection between the side walls 33 and the connection plate 34.

As can be seen in Fig. 12, there is clearance between the side walls 33 and the structural member 11. This clearance enables the fishplate connections 37 to locate through the apertures 35 between the side walls 33 and the structural member 11. Sufficient clearance is provided for a pair of fishplates 37 to locate in this clearance.

The side walls 33 of the bracket have an edge portion 38 extending inwardly with respect to the structural member 11 which extend the length of the bracket 32. When the bracket 32 is located on the structural member 11 prior to fixing of the bracket 32, the edge portions 38 assist in locating the bracket on the structural member 11 thus allowing the fishplate connectors 37 to be slid into position through the apertures 35. The fishplate connectors 37 are provided with U-shaped ends 40 which allow other structural members 11 to be secured to the fishplate

connector 37.

In order to form the joint, once the bracket 32 and the fishplate 37 are in position, fasteners 42 may be located through the back (as is shown in Fig. 11). Self-tapping screws or rivets may be suitable for this application. As can be seen in Fig. 11, both the bracket 32 and the fishplate connectors 37 are secured to the structural member once the fasteners 42 are in place.

A major advantage of using the bracket 32 in relation to the first aspect of the invention described in this specification is that the load applied to the bracket is transferred from the side walls or webs of the structural member to the flange portion of the structural member. This is particularly useful as the web portion of the structural member may be thin and therefore unable to support any substantial load. Further, the double plate of the flange subject to the first aspect of this invention does not provide ample support, and therefore there is significant advantage in the transfer of this load.

A further advantage in this aspect of the invention is that the various structural members forming the joint may be positioned over a wide range of angles with respect to one another.

Although the bracket subject of this aspect of the invention is particularly useful in relation to roll formed metal sections which are the subject of the first aspect of this invention, the bracket and its method of connection will be useful in respect of many types of structural members whether they be tubular or solid.

It will be recognised by persons skilled in the art that numerous variations and modifications may be made to the invention as broadly described herein without departing from the overall spirit and scope of the invention.

The claims defining the invention are as follows:

1. A profiled structural element for use with a complementary structural element of like profile to form a composite structural member; each profiled element comprising; a web, upper and lower main flanges separated by the web, a return on each of the upper and lower main flanges which forms a sub-flange, characterised in that the web is provided with transversely or vertically extending corrugations which provide increased resistance against buckling.

2. A profiled structural element according to claim 1 wherein each element is substantially channel shaped.

3. A profiled structural element according to claim 2 wherein, when a composite structural member is to be formed, the open faces of the channels are placed in opposition to each other then pressed together so that the upper and lower flanges overlap so that the convex portion of one web is contiguous with the concave portion of the web of an adjacent element.

4. A profiled structural element according to claim 3 wherein each of said sub-flanges are formed with a plurality of stakes which locate in corresponding apertures formed in the web of the complementary structural element when the structural member is formed.

5. A profiled structural element according to claim 3 wherein, when two elements combine to form a composite structural member the elements may be held together by means of spot welding, intermittent welding, blind rivets or like fasteners.

6. A profiled structural element according to claim 4 or 5 wherein each of the upper and/or lower flanges have formed therein at least one longitudinal strengthening rib.

7. A profiled structural element according to claim 6 wherein the said stakes or like fasteners inhibit or prevent movement of one element relative to the other such that the so formed structural member acts as a unitary member.

8. A profiled structural element according to claim 7 wherein the corrugations in the web terminate at a predetermined distance from the sub flanges of that element

or at a point where the extremity of each of the sub-flanges of a complementary profiled element engages with the web.

9. A profiled structural element according to claim 8 wherein the corrugations have a wavelength within the range of 16 times to 60 times the thickness of the element material.

10. A profiled structural element according to claim 9 wherein the crest of each corrugation has a radius within the range of 5 times to 10 times the thickness of the element material.

11. A profiled structural element according to claim 10 wherein the corrugations have a pitch within the range of 2 times to 20 times the element material thickness.

12. A profiled structural element according to claim 11 wherein the thickness of the element material falls within the range of 0.3 mm to 1.0 mm.

13. A profiled structural element according to claim 12 when mated with a like profiled element, forms a member having the appearance and torsional characteristics of a box sectioned structural member.

14. A profiled structural element according to claim 13 wherein the composite structural member so formed acts as a structural beam.

15. A profiled structural element according to claim 14 wherein the composite structural member so formed combines with like members to form a truss.

16. A profiled structural element according to claim 15 wherein the structural element is made from aluminium or steel.

17. A joining bracket for use with the composite structural member formed by the profiled elements as hereinbefore described, said bracket comprising; at least one sidewall, a connector plate attached to the sidewall, and at least one aperture formed between the sidewall and the connector plate.

18. A bracket according to claim 17 wherein the bracket is a substantially U shaped channel having a pair of sidewalls and a connector plate between the sidewalls.

19. A bracket according to claim 18 wherein a pair of apertures are formed at each intersecting edge between the

connector plate and the sidewalls.

20. A bracket according to claim 19 wherein, in use, the bracket is placed in a sleeve like manner over the structural member to which the bracket is to be connected such that a clearance remains between the sidewall and the structural member.

21. A bracket according to claim 20 wherein a plate is inserted through the aperture and secured between the bracket and the structural member.

22. A method of construction of a profiled structural element as herein described, for use with a like profiled element to form a composite structural member, comprising the steps of:

(a) taking a metal sheet of a predetermined width and length,

(b) bending the sheet by use of a series of rollers so as to form a substantially channel shaped member, comprising a web, upper and lower main flanges and a return on each of said upper and lower main flanges forming sub-flanges,

(c) roll forming the channel member during or after its formation to form ribs in the sub-flanges,

(d) forming corrugations before or after step (b) transversely or vertically in the web of the profiled element.

23. A method according to claim 22 comprising the further steps of:

(a) cutting the formed section to a predetermined length,

(b) inverting the cut section over an internal mandrel,

(c) rolling the section through a tool which pierces the web to form a plurality of stakes near the sub flanges at predetermined intervals enabling fastening of each sub flange to its adjacent web when a composite structural member is to be formed.

24. A method according to claim 23 wherein the corrugations are formed by rolling or stamping.

25. A method of construction of a profiled structural element as hereinbefore described comprising the steps of:

(a) folding a metal sheet of predetermined length and width

to form a substantially channel shaped element,

(b) either before or after the folding, forming corrugations in that part of the sheet which forms the web of the element, by either stamping or rolling.

26. A method according to claim 25 comprising the additional step of passing the element through a rolling tool which pierces the web to form a plurality of stakes in the sub flanges at predetermined intervals.

27. A method according to claim 26 wherein the stakes are formed with a reciprocating die.

28. A method according to claim 27 wherein the stakes are staggered along the length of element.

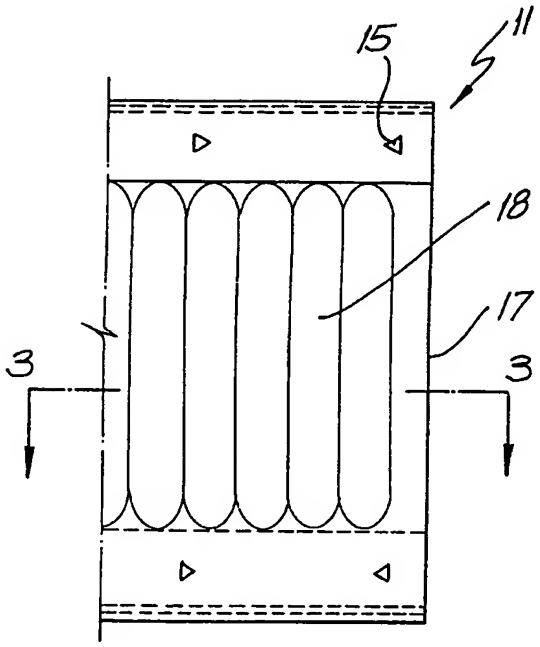

FIG. 1

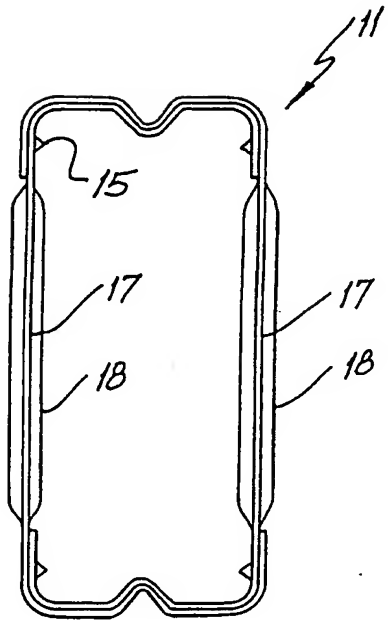

FIG. 2

FIG. 3

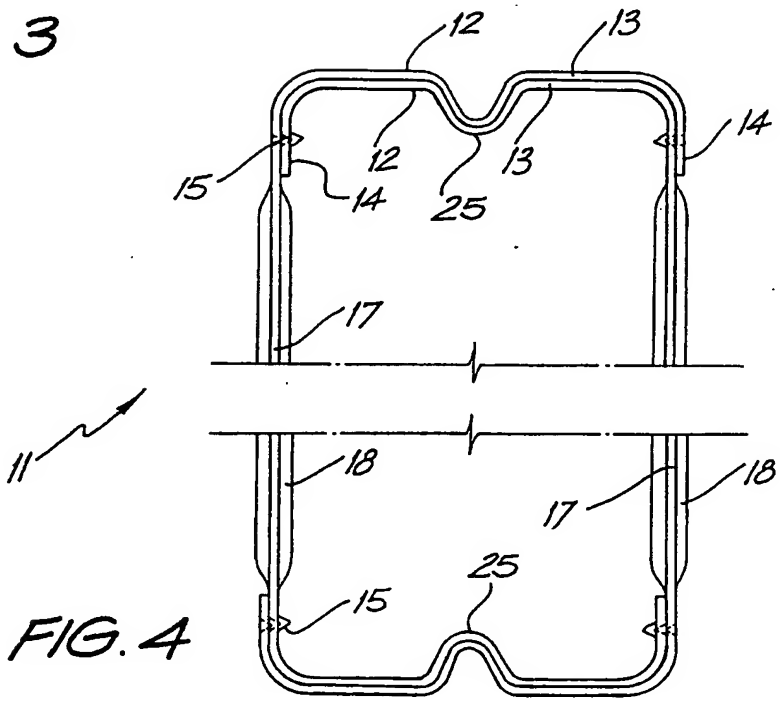

FIG. 4

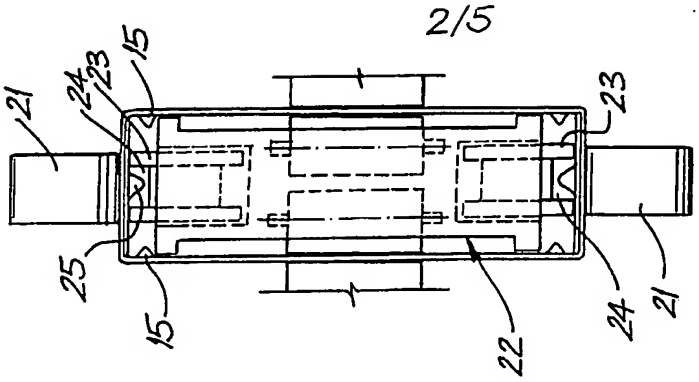

FIG. 6

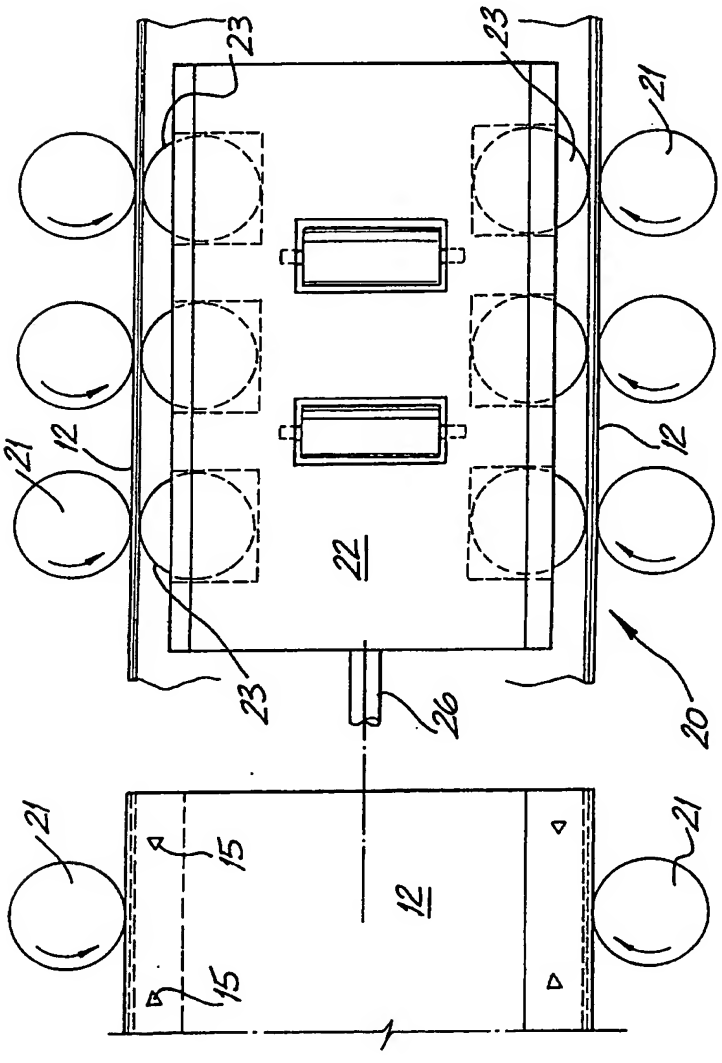

FIG. 5

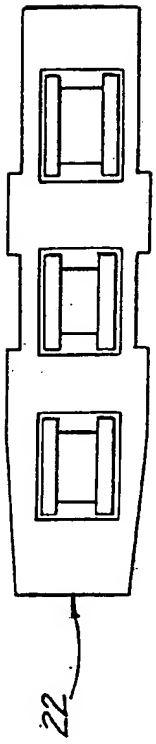

FIG. 7

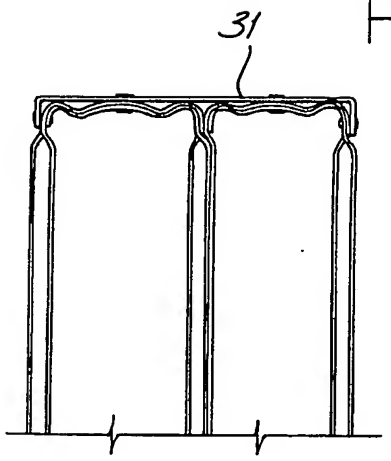

FIG. 8

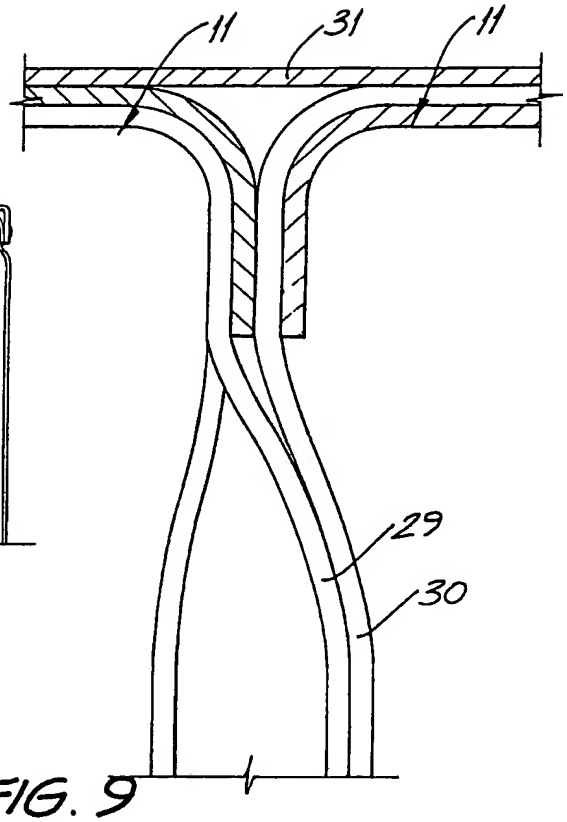

FIG. 9

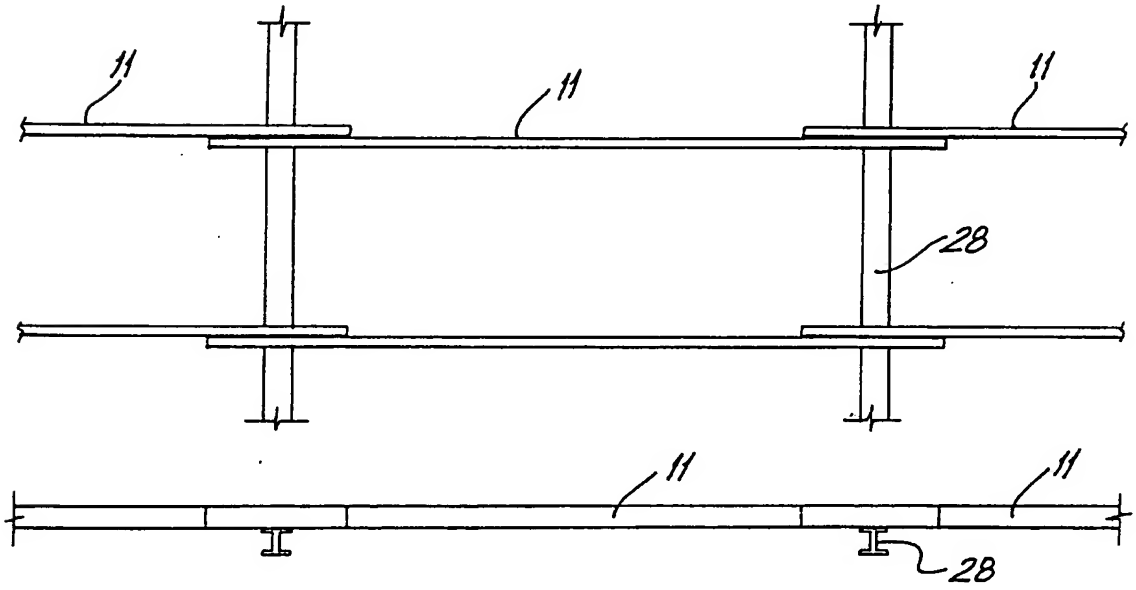

FIG. 10

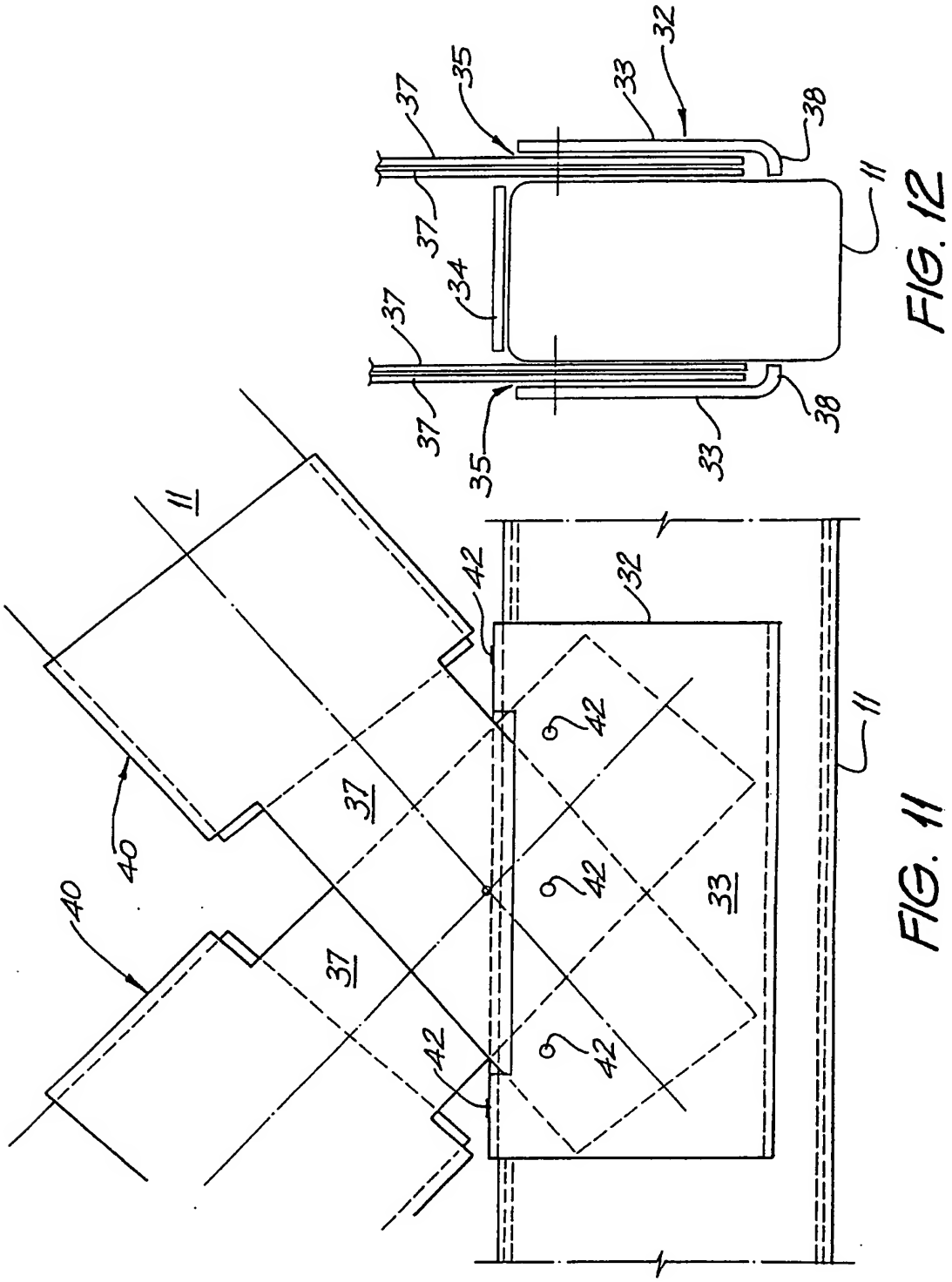
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FIG. 11

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FIG. 12

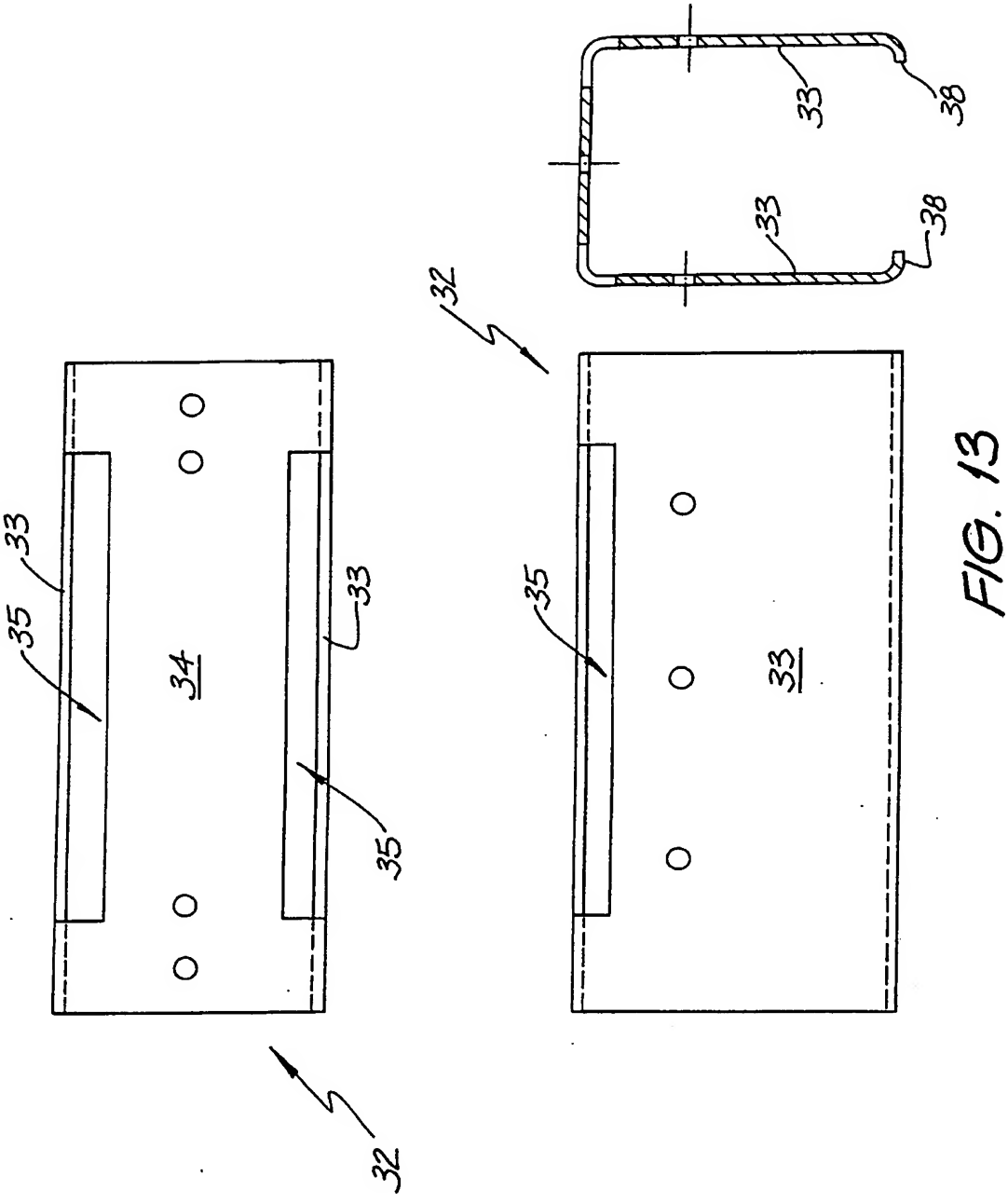

FIG. 13

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU93/00035

A. CLASSIFICATION OF SUBJECT MATTER
Int. Cl.[5] F16S 3/00, 3/06, B21B 1/38, 1/22, B21D 13/04

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC: F16S 3/00, 3/06, B21B 1/38, 1/22, B21D 13/04

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
AU: IPC as above

Electronic data base consulted during the international search (name of data base, and where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to Claim No.
	AU,A,69549/91 (PELL-MELL PTY LTD) 27 June 1991 (27.06.91)	
X	Figure 1	1-3,5-16,22,25
Y		4,23,24,26-28
A	Figure 3	17-21
	FR,A,2568668 (PROFILAFROID S.A.) 7 February 1986 (07.02.86)	
X	Figure 2	1-3,5,8-16,22,25
Y		4,23,24,26-28

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
30 April 1993 (30.04.93)	18 MAY 1993 (18.05.93)

Name and mailing address of the ISA/AU	Authorized officer
AUSTRALIAN PATENT OFFICE PO BOX 200 WODEN ACT 2606 AUSTRALIA	for G.M. COX
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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate of the relevant passages	Relevant to Claim No.
Y	GB,A,1487244 (VALLOUREC) 28 September 1977 (28.09.77)	4,23,24,26-28
X	Figure 1	1-3,5,8-16,22,25
Y	GB,A,849321 (PAGAN) 21 September 1960 (21.09.60)	4,23,24,26-28
X	Figure 1	1-3,5,8-16,22,25
A	GB,A,2171731 (HAYWARD) 3 September 1986 (03.09.86) Figure 1	1-3,5,7-16,22,25
A	GB,A,1441746 (WARD BROTHERS (SHERBURN) LIMITED) 7 July 1976 (07.07.76) Figure 1	1-3,5-7,12-16,22,25
A	US,A,4047354 (SUTHERLAND) 13 September 1977 (13.09.77) Figures 4 and 5	1,22,25
X	AU,A,43359/89 (SILADY) 19 April 1990 (19.04.90) Figures 3 and 4	1,2
A		22,25
A	EP,A,446158 (ETABLISSEMENTS RAVOYARD KIT 2000 S.A.) 11 September 1991 (11.09.91) Figure 1	1,22,25
A	AU,B,55803/73 (475238) (A.C.I. OPERATIONS PTY. LTD.) 9 January 1975 (09.01.75) Figures 1 and 2	22,25
A	GB,A,1174233 (REDMAN HEENAN INTERNATIONAL LIMITED) 17 December 1969 (17.12.69) Figures 1 to 3	22,25
A	AU,22141/45 (127852) (ECOFIX LTD) 27 July 1945 (27.07.45) Figure 12	17-21
A	AU,1816/54 (209254) (STUBBS et al) 19 January 1956 (19.01.56) Figures 1, 3 and 5	17-21
A	DE,A,3540027 (NORD) 15 May 1986 (15.05.86) Figures 1-3	1-3,5-16,22,25
Y		4,23,24,26-28
X	AU,B,65438/80 (535989) (BURNDY INC) 23 July 1981 (23.07.81) Figures 1, 2	1,2,22,25
X	AU,B,42892/78 (527459) (RACEWAY SYSTEMS PTY. LTD.) 19 July 1979 (19.07.79) Figures 1, 2	1,2,22,25
X	AU,B,21883/88 (609886) (SIEMENS LTD) 16 March 1989 (16.03.89) Figures 1 2	1,2,17,18

Box I **Observations where certain claims were found unsearchable (Continuation of Item 1 of first sheet)**

This international search report has not established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claim Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II **Observations where unity of invention is lacking (Continuation of item 2 of first sheet)**

This International Searching Authority found multiple inventions in this international application, as follows:

1. Claims 1-16, 22-26

profiled structural element for use with a complementary structural element of like profile to form a composite structural member and a method of construction of the profiled structural member.

2. Claims 17-21

joining bracket for use with the composite structural member formed by the profiled elements.

As reasoned on the extra sheet.

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims

2. ☒ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically

claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest.

☐ No protest accompanied the payment of additional search fees.

(continuation) BOX II

The international application does not comply with the requirements of unity of invention because it does not relate to one invention or to a group of inventions so linked as to form a single general inventive concept. In coming to this conclusion the International Search Authority has found that there are two inventions:

1. Claims 1-16 are directed to a profiled structural element for use with a complementary structural element of like profile to form a composite structural member, each profiled element has a web, upper and lower main flanges separated by the web, a return on each of the flanges, the web being provided with transversely or vertically extending corrugations and the return of each of the flanges have a plurality of stakes. Claims 22-26 are directed to a method of constructing the profile structural element of claims 1-16. It is considered that the corrugations on the web and the stakes on each of the returns comprise a first "special technical feature".

2. Claims 17-21 are directed to a joining bracket for use with the composite structural member of claims 1-16 and 22-26, the bracket having at least a side wall, a connector plate attached to the side wall, and at least one aperture formed between the side wall and the connector plate. The aperture between the side wall and the connector plate is considered to be a second "special technical feature".

Since the abovementioned groups of claims do not share either of the technical features identified, a "technical relationship" between the inventions, as defined in PCT rule 13.2 does not exist. Accordingly the international application does not relate to one invention or to a single inventive concept.

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report	Patent Family Member
AU 69549/91	CA 2047224, CN 1054640, EP 457877, WO 9109252, ZA 9009681
FR 2568668	DE 8522091
GB 1487244	BE 820969, ES 430922, FR 2247597, IT 1022813
GB 2171731	
GB 1441746	DE 2350618, FR 2213113, IE 38585, IT 996800, ZA 7307875
US 4047354	AU 26048/77
AU 43359/89	NZ 230840, WO 9003921
EP 446158	FR 2658549
AU 55803/73	DE 2361078, FR 2210272, GB 1456530, JP 57038329, US 4074495
DE 3540027	DK 5436/84, GB 2167463, NO 854540, SE 8505069, US 4691493
AU 21883/88	NZ 226066
AU 42892/78	
AU 65438/80	

END OF ANNEX